SUMMARY OF PROPOSED CHANGES TO DCPRS CERTIFICATION STANDARD

This document contains a set of proposed changes to the DCPRS Certification Standard, primarily to prepare the DCS for a large step in capacity by the time GOES R is launched, estimated to be about 2012. The intent is to double the number of channels that comprise the DCPR by splitting the existing channels in half. The band from 401.7 MHz to 402.0 MHz will then be able to support 400 channels at 0.75 kHz for 300 bps operation, 200 channels at 1.5 kHz for 1200 bps operation, or a combination thereof. This channelization will continue into the band 402.0 MHz to 402.1 MHz, GOES International channels, although current plans are to stay with the current 3.0 kHz channel spacing, i.e., NOAA will require DCPRS be able to operate at the reduced channel spacing over the entire 400 kHz. The capacity of the DCS will also be increased by tightening the timing requirements so more messages can be scheduled at shorter intervals.

A number of requirements in the Certification Standard need to be changed to prepare for this improved capacity. NOAA believes the changes proposed are within the technical capacity shown by the equipment that has been certified to the existing standard and that the improved capabilities can be provided at a relatively small increase in cost. In most cases, the changes must be fully implemented in the operating DCPRS transmitters and the CDAS and DRGS receive equipment, before actual changes in system operation can occur. NOAA is therefore providing this opportunity for review and discussion so the revised certification standard can be put in place as soon as possible. Vendors and users can then have as long a period as possible to make the changes to their equipment.

The proposed changes will tighten the frequency, timing, and filtering requirements, affecting subsections 2.1, 3.9, 4.2, 4.22, 4.51, and 4.52. They also reduce the uplink power variation allowed, subsection 4.1.1; propose the elimination of the interleaver and most prohibited characters, but double the number of flush bits, subsections 3.1, 3.4, 3.5, and 3.7.1; apply more definitive phase noise requirements, subsections 4.3.2 and 4.4; and reduce the maximum message length for 300 bps channels, subsections 3.8 and 4.6. Additional clarifications and minor corrections of typos, etc., have also been included.

Subsections that are not included in the following pages are intended to be retained as they are.

The proposed changes also include Appendix C, which covers the DCPI link. This link does not comply with the ITU Power Flux Density (PFD) requirements as it is presently configured and therefore should be revised or eliminated as soon as possible. The proposed revision is one of several possible system designs that could make it of more benefit to potential users. Users and manufacturers are encouraged to offer additional or different designs, performance requirements, etc., that could help keep this link in operation. (If this link is not used, future spacecraft will be unlikely to provide this service.)

DESCRIPTION OF THE PROPOSED CHANGES IN NUMERICAL ORDER

A. Subsection 2.1

A1. CURRENT VERSION OF SUBSECTION 2.1:

2.1 DCPRS Self- Timed Reporting Mode Requirements

All DCPRS designated for self-timed operations shall fulfill the timing requirements identified below.

2.1.1 300 BPS Reporting Time Accuracy

Manufacturer's shall demonstrate that self-timed reporting will have a drift of no more than ± 30 seconds per year. Manufacturer's may use a combination of analysis with oscillator drift data and DCP software utilized.

The DCPRS shall be demonstrated to operate for 48 hours on a NOAA/NESDIS assigned channel and time slot. The timing accuracy shall not exceed a prorated ± 30 seconds per year.

2.1.2. 1200 BPS Reporting Time Accuracy

All 1200 BPS DCPRS transmissions shall be within ± 0.5 seconds of the assigned reporting time with a probability of 99.9% within any one year period and at any temperature over a range of -40°C to +50°C. This shall include any inaccuracies associated with the initial setting of the clock by the user as specified in paragraph 2.1.5 below.

2.1.3 DCPRS Time Reference

DCPRS reporting time shall always be with respect to Coordinated Universal Time (UTC).

2.1.4. Inhibiting Transmissions

Should that the DCPRS clock differs by more than ± 0.5 seconds from the Coordinated Universal Time (UTC) at time of transmission, transmission (including RF carrier) shall be inhibited (i.e. shall be canceled). After an inhibited transmission should the DCPRS clock be restored to less than ± 0.5 seconds from Coordinated Universal Time (UTC), the DCPRS may resume normal transmissions.

2.1.5 Setting and Verifying the DCPRS Clock

Manufacturer's shall provided a method to enable a user to set the DCPRS clock to an accuracy of within ± 0.1 seconds of Coordinated Universal Time (UTC). The needed equipment and software must be available from the DCPRS vendor to verify the accuracy of the DCPRS clock after it has been set.

NOTE: The requirements in paragraphs 2.1.4 and 2.1.5 are mandatory for the 1200 BPS DCP and are optional for the 300 BPS DCP.

A2. PROPOSED REVISED VERSION OF SUBSECTION 2.1:

2.1 DCPRS Self- Timed Reporting Mode Accuracy

All DCPRS transmissions shall be within ± 0.1 seconds of the assigned reporting time with a probability of 99.9% within any one year period and over the full range of operating conditions. This shall include any inaccuracies associated with the initial setting of the clock by the user as specified in paragraph 2.1.3 below.

2.1.1 DCPRS Time Reference

DCPRS reporting time shall always be with respect to Coordinated Universal Time (UTC). GPS shall be used as the time reference for all DCPRS.

2.1.2. Inhibiting Transmissions

Should the DCPRS clock differ by more than ± 0.2 seconds from the UTC at time of transmission, transmission (including RF carrier) shall be inhibited (i.e. shall be canceled). After an inhibited transmission, the DCPRS clock shall be restored to less than ± 0.1 seconds from UTC before the DCPRS may resume normal transmissions.

2.1.3 Setting and Verifying the DCPRS Clock

Manufacturer's shall provided a method to enable a user to set the DCPRS clock to an accuracy of within ± 0.1 seconds of UTC. The needed equipment and software must be available from the DCPRS vendor to verify the accuracy of the DCPRS clock after it has been set. This shall include a method to predict the clock accuracy at specific intervals after the clock has been set as may be necessary for normal transmission accuracy.

B. **Subsection 3.1**

B1. CURRENT VERSION OF SUBSECTION 3.1:

3.1 DCPRS Data Format. The figure below defines the required message format.

*0.5s / 0.25s Carrier	3 '0 -1' Clock States	15 bit FSS	31 bit GOES ID 4 - 8 bit Bytes	Flag Word 8 Bits	DCP DATA Up to 126,000 bits (maximum)	EOT	Encoder Flush 16 bits

↑ Start of Scrambling, Coding, and Interleaving

NOTES: ASCII EOT used for ASCII and Pseudo Binary formats
International EOT used for Binary Format
Actual Message Length may not Exceed Fail-Safe Limits

For each of the blocks a "0" = represent 0 degrees and a "1" represents 180 degrees.

***Carrier**: 0.50 seconds for 300 BPS
0.25 seconds for 1200 BPS

Clock: 3 "0 and 180" degree phase transitions (0-1, 1-0, 0-1)at the respective symbol data rate

Frame Synchronization Sequence (FSS) - Three possible 15 bit Patterns:

	No Interleaver	Short Interleaver	Long Interleaver
Binary	MSB 000001011001110	000100011101001	001111100110101
Hexadecimal (implied ("0" as MSB)	02CE	08E9	1F35

GOES ID/DCP address: 31 bits plus LSB assumed as a "0" to form 4 - 8 bits Bytes

Flag Word: (LSB) Bit 1 spare, undefined
Bit 2 Clock updated since last transmission = 1, not = 0
Bit 3 Data Compression on =1, off = 0 Possible Future Enhancement
Bit 4 Reed Solomon on = 1, off = 0 Possible Future Enhancement
Bit 5 spare, undefined
Bits 6 & 7 ASCII = 10, Pseudo Binary = 11, Binary = 01
(MSB) Bit 8 Odd parity for ASCII formatted data

The FSS consists of three possible 15 bit words where 0 degrees = “0” and 180 degrees= “1” transmitted at the symbol rate. The left most bit is transmitted first.

After the FSS is transmitted the remainder of the format is presented as eight (8) bit bytes. If an interleaver is enabled the respective FSS word shall be generated. After the FSS is transmitted the GOES ID and all data shall be scrambled, trellis encoded, and interleaved as defined in paragraph 3.5 below.

The GOES ID is a 31-bit Bose-Chaudhuri-Hocquenghem (BCH) address with a zero implied as the 32^{nd} LSB. This address shall be transmitted as the first 4 bytes of the data in the message in exactly the same manner as all the other data bytes in the message. For example, given the hex ID of **CE 12 00 B8**, the first byte transmitted is **CE** hex, followed by **12** Hex, followed by **00** hex, followed by **B8** hex or **11001110 00010010 00000000 10111000.**

B2. PROPOSED REVISED VERSION OF SUBSECTION 3.1:

NOTE: The changes shown below also include the results due to other changed detailed in following parts of this document.

3.1 DCPRS Data Format.

The format for all messages shall meet the following format requirements.

Carrier 0.5s/ 0.25s	Clock States 3 '0-1'	FSS 15 bits	GOES ID 32 bits	Flag Word 8 bits	DCP DATA Max: 31,500 bits @ 300 bps 126,000 bits @ 1200 bps	EOT	Encoder Flush 32 bits

Start of Scrambling and Coding

NOTES: ASCII EOT use for ASCII and Pseudo Binary Formats
International EOT used for Binary Format
Actual Message Length may not Exceed Fail-Safe Limits

Carrier: 0.50 seconds for 300 BPS
0.25 seconds for 1200 BPS

Clock: 3 symbol periods, first 0 degrees, then 180 degrees, then 0 degrees.

Frame Synchronization Sequence (FSS):
The following 15 bit pattern shall be sent at the appropriate symbol rate with "0" representing 0 degrees and "1" representing 180 degrees:
(MSB) 000001011001110 (LSB) The left most bit is transmitted first.

After the FSS is transmitted the GOES ID and all data shall be scrambled, and trellis encoded, as defined below.

GOES ID/DCP address:
31 bits plus an extra "0" inserted as the LSB to form 4 - 8 bits Bytes

The GOES ID is a 31-bit Bose-Chaudhuri-Hocquenghem (BCH) encoded address with a zero included as the 32nd LSB. This address shall be transmitted as the first 4 bytes of the data in the message in exactly the same manner as all the other data bytes in the message. For example, given the hex ID of **CE 12 00 B8**, the first byte transmitted is **CE** hex, followed by **12** Hex, followed by **00** hex, followed by **B8** hex or **11001110 00010010 00000000 10111000.**

Flag Word: (LSB)	Bit 1	spare, undefined
	Bit 2	Clock updated since last transmission = 1, not = 0
	Bit 3	Data Compression on =1, off = 0 Possible Future Enhancement
	Bit 4	New Coding on = 1, off = 0 Possible Future Enhancement (Code format not yet defined)
	Bit 5	spare, undefined
	Bit 6	= 1 if ASCII or Pseudo Binary, otherwise = 0
	Bit 7	= 1 if Pseudo Binary or Binary, otherwise = 0
(MSB)	Bit 8	Odd parity for ASCII formatted data

## C.	Subsection 3.2

***C1.	CURRENT VERSION OF SUBSECTION 3.2:***

### 3.2	Data Scrambling

At the beginning of the GOES ID all DCP data must be scrambled. Each data byte is scrambled by “exclusive ORing” (XOR) the byte with a byte from the following 40 byte table. The first byte is XORed with the first byte in the table (53 hex). The next byte is XORed with the second byte in the table (12 hex), and so on. After the 40th byte has been scrambled the next scramble byte to be used is the first byte (53 hex). The below table is to be used in a circular fashion throughout the message.

53	12	72	B2	54	62	AA	E4	DB	A7	56	08	A8	09	B4	BF	61	DC	50	E3
AB	7F	00	87	6D	F5	58	CC	CF	3E	E7	2A	7E	9B	5C	4D	CE	A5	3C	0A

This array is treated as a single binary string where each data binary pair generates one symbol. BAD hex is the first scrambled symbol output and recycles after 160 input symbols.   This array shall be cycled through as many times as required for the duration of the message data.

C2. PROPOSED REVISED VERSION OF SUBSECTION 3.2:

3.2 Data Scrambling

Starting with the first bit of the GOES ID, all DCPRS data shall be scrambled. The DCPRS serial data stream shall be "exclusive ORed" (XOR) with the serial binary string represented by the table below. It is shown as 40 bytes using hex symbols for convenience, and shall be used in a circular fashion throughout the message.

53	12	72	B2	54	62	AA	E4	DB	A7	56	08	A8	09	B4	BF	61	DC	50	E3
AB	7F	00	87	6D	F5	58	CC	CF	3E	E7	2A	7E	9B	5C	4D	CE	A5	3C	0A

For example, the first byte of the GOES ID example, CE (hex), would be XOR with the first byte in the table, 53 (hex), i.e., the serial string 1100 1110 XOR with the serial string 0101 0011 to produce 1001 1101, or 9D (hex). Then the second byte of the GOES ID, 12 (hex), would be XOR with the second byte in the table, 12 (hex), to produce 00 (hex), and so on. After the last byte of the table 0A (hex), has been XOR with the 40th byte of the DCPRS message, the table would be cycled and the 41st message byte XOR with the first byte in the table, 53 (hex). This sequence would continue as many times as required for the duration of the message, including the EOT and flush bits.

D. Subsection 3.4

D1. CURRENT VERSION OF SUBSECTION 3.4:

3.4 Encoder Flush

At the end of the message after transmitting the EOT an additional 16 zero (0) data bits shall be provided to flush the encoder. After the 16th flush bit is transmitted, the interleaver, if used, shall be unloaded per para. 3.5.2, the phase should be brought to zero and the carrier power shall be turned off.

D2. PROPOSED REVISION TO SUBSECTION 3.4:

3.4 Encoder Flush

At the end of the message after transmitting the EOT, an additional 32 zero (0) data bits shall be provided to flush the encoder and decoder. After the 32nd flush bit is transmitted, the phase should be brought to zero and the carrier power shall be turned off.

E. Subsection 3.5

This subsection describes interleaver requirements, however, NOAA's technical advisors can find no benefit provided by these interleavers in this application, but have found there is a significant "cost" due to the additional transmission time needed to unload the interleaver.

IT IS THEREFORE PROPOSED TO DELETE SUBSECTION 3.5 IN ITS ENTIRETY.

If any user or manufacturer has any data indicating any benefit from using an interleaver in the DCS, they should provide it so NOAA can perform a cost/benefit analysis.

F. Subsection 3.7.1

F1. CURRENT VERSION OF SUBSECTION 3.7.1:

3.7.1 Prohibited Characters

For ASCII or Pseudo Binary format the following control characters are prohibited: DLE, NAK, SYN, ETB, CAN, GS, RS, SOH, STX, ETX, ENQ, ACK, and EOT. For DCPRS certification testing a set of five messages of at least 500 characters in length shall be sent in a pre-defined ASCII character set. The test demodulator output will be capable of extracting this transmitted text.

For binary mode certification a fixed set of binary values is sent five times. The string should be at least 256 bytes long. The precise format and error checking for HDR binary transmissions is TBD.

F2. PROPOSED REVISION TO SUBSECTION 3.7.1:

a. NOAA proposes to lift the prohibition on all characters except EOT. If any interested party has any reason to suggest the prohibition should be retained for any other character, they are requested to notify NOAA as soon as possible.
b. NOAA requests any interested party to offer a specific format and performance checking method for HDR binary transmissions so that a formal standard can be set.

G. Subsection 3.7.2

G1. CURRENT VERSION OF SUBSECTION 3.7.2:

3.7.2 End Of Transmission (EOT)

ASCII and Pseudo Binary Format Mode - An EOT code word, bit pattern 00000100 - LSB first, shall be sent immediately after the last symbol of sensor data. This bit pattern is an ASCII EOT with odd parity.

Binary Mode - An (EOT) code word, bit pattern 1100011110010101110100000100 - LSB first, shall be sent immediately after the last symbol of sensor data. This bit pattern is identical to that required for international DCPRS certification.

G2. PROPOSED REVISED VERSION OF SUBSECTION 3.7.2:

3.7.2 End Of Transmission (EOT)

ASCII and Pseudo Binary Format Mode - An EOT code word, bit pattern 00000100, transmitted with the LSB first, shall be sent immediately after the last symbol of sensor data. This bit pattern is an ASCII EOT with odd parity.

Binary Mode - An (EOT) code word, 0110 0011 1100 1010 1101 1101 0000 0100 with the LSB transmitted first, shall be sent immediately after the last symbol of sensor data. This bit pattern is identical to that required for international DCPRS certification except an additional zero (0) is inserted as the MSB to provide an even number of bits to be sent to the encoder.

H. Subsection 3.8

This subsection defines the maximum message length, but it is, partly, in conflict with the fail-safe message length requirement in subsection 4.6.

IT IS THEREFORE PROPOSED TO DELETE SUBSECTION 3.8 IN ITS ENTIRETY.

I. Subsection 3.9

This subsection requires that the room temperature frequency adjustment be within 25 Hz. NOAA intends to require that the transmitted carrier frequency be held to much better accuracy than was previously required, see item L below. However, NOAA has also concluded that the critical parameter is the worst case frequency variation from perfect accuracy, not precision of adjustment.

IT IS THEREFORE PROPOSED TO DELETE SUBSECTION 3.9 IN ITS ENTIRETY.

J. Subsection 4.1.1

J1. CURRENT VERSION OF SUBSECTION 4.1.1:

4.1.1 RF Power Output

For 300 bps the DCPRS shall have a nominal EIRP of 48 dBm - Carrier only and a maximum EIRP of 50 dBm under any combination of power supply or temperature variation.

For 1200 bps the DCPRS shall have a nominal EIRP of 51 dBm - Carrier only and a maximum EIRP of 53 dBm under any combination of power supply or temperature variation.

Note: During the random modulation portion of the message the output power will be 1 dB less (See Appendix E paragraph 1- test notes for a discussion of RMS transmitted power).
DCPRS EIRP testing shall include a test to show the transmit amplifier 1 dB compression point. The DCPRS phase noise measurement shall be made with the transmitter operated at or above the 1 dB compression point.

J2. PROPOSED REVISION TO SUBSECTION 4.1.1:

4.1.1 RF Power Output

For 300 bps, the DCPRS shall have a maximum EIRP of 50 dBmi and a minium EIRP of 47 dBmi. For 1200 bps, the DCPRS shall have a maximum EIRP of 53 dBmi and a minium EIRP of 50 dBmi. These limits shall be met under any combination of operational conditions.

NOTE: The satellite transponder has been designed to operate over the uplink EIRPs listed above. Levels higher that the maximum will tend to overload the transponder and are prohibited. Levels less than the minimum may not provide an acceptable error rate when a large number if channels are simultaneously active. The minimum is cited because it is the lower limit of the system design, but users are permitted to use lower EIRP at their own risk.

K. Subsection 4.2

K1. CURRENT VERSION OF SUBSECTION 4.2:

4.2 GOES DCS Operating Frequency Requirements

The GOES domestic DCS operates at UHF from 401.7 MHz to 402.0 MHz with either 200- 1.5

kHz channels @ 100/300 bps, 100 - 3.0 kHz channels @ 1200 bps or a combination thereof. The GOES international DCS operates from 402.0 MHz to 402.1 MHz with 33-3kHz channels. Although the 300 bps and 1200 bps DCPRS has not been adopted or approved for use in the international DCS, 3 kHz tuning from 402.0 MHz to 402.1 MHz is required for all HDR DCPRS.

K2. PROPOSED REVISION TO SUBSECTION 4.2:

4.2 GOES DCS Operating Frequency Requirements

The DCPRS shall be able to operate at any of the channel center frequencies designated below.

For DCPRS operating at 300 bps:
The DCPRS shall be able to tune to 532 channels at 750 Hz increments, from 401.701000 MHz to 402.099250 MHz. The channel 1 center frequency shall be 401.701000 MHz, channel 2 center frequency shall be 401.701750 MHz, channel 3 center frequency shall be 401.702500 MHz, etc., up to channel 532 at 402.099250 MHz

For DCPRS operating at 1200 bps:
The DCPRS shall be able to tune to 266 channels at 1500 Hz increments, from 401.701000 MHz to 402.098500 MHz. The channel 1 center frequency shall be 401.701000 MHz, channel 2 center frequency shall be 401.702500 MHz, channel 3 center frequency shall be 401.704000 MHz, etc., up to channel 266 at 402.098500 MHz

L. Subsection 4.2.2

L1. CURRENT VERSION OF SUBSECTION 4.2.2:

4.2.2 Frequency Stability, Long Term

The DCPRS output frequency shall maintain a long term aging stability of $\pm$ 0.5 PPM and be permitted an additional $\pm$ 0.5 PPM of drift under any combination of power supply variation or temperatures set forth in paragraph 4.0 on any channel frequency defined in Appendix D. The output frequency shall be maintained to within $\pm$ 425 Hz of the channel center.

L2. PROPOSED REVISION TO SUBSECTION 4.2.2:

4.2.2 Frequency Stability, Long Term

The DCPRS output frequency shall be maintained to within $\pm$ 30 Hz of the channel center frequency due to any combination of operational conditions and on any channel frequency.

M. Subsection 4.3.2

M1. CURRENT VERSION OF SUBSECTION 4.3.2:

4.3.2 DCPRS 8-ary Modulator Stability

The 8-ary modulator shall maintain a stability/accuracy of $\leq \pm$ 2.5 degrees under any combination of power supply or temperature variation as defined in paragraph 4.0 (See Appendix E - GOES DCS Certification Test Notes Paragraph 3.0 Phase Measurement).

M2 PROPOSED REVISION TO SUBSECTION 4.3.2:

IT IS THEREFORE PROPOSED TO DELETE SUBSECTION 4.3.2 IN ITS ENTIRETY.
(NOAA intends to require improved phase accuracy, but will combine all phase stability and accuracy parameters into one requirement. See item N below.)

N. Subsection 4.4

N1. CURRENT VERSION OF SUBSECTION 4.4, INCLUDING 4.4.1 AND 4.4.2:

4.4 DCPRS Phase Noise

4.4.1 DCPRS Carrier Phase Noise

The DCPRS carrier phase noise shall be < 2.5 degrees RMS under any combination of power supply or temperature variation as defined in paragraph 4.0.

DCPRS RMS phase noise is to be measured during transmission of carrier only. First the test set up residual noise from the receiver and signal generator shall be measured. This should be < 0.2 degrees. Then measure the DCPRS phase noise. Subtract the residual set up phase noise from the DCPRS phase noise.

The DCPRS phase noise measurement is to be made at the "Q" output of the test demodulator. While making this measurement the test signal should be observed on an oscilloscope. Test data can be extracted from the test demodulator program or by using RMS voltmeter with a 2000 Hz response at the 1200 BPS data rate.

4.4.2 DCPRS Dynamic Phase Noise (Inter Symbol Interference (ISI))

The DCPRS dynamic phase noise or ISI shall be $\leq$ 1.5 degrees RMS (see Appendix E - GOES DCS Certification Test Notes Para. 2.0 Phase Error Budget) which provides a recommended measurement process.

N2. PROPOSED REVISION TO SUBSECTION 4.4:

4.4 DCPRS Phase Noise

The total phase noise and bias due to all causes and under any combination of operational conditions, shall be less than 3.0 degrees RMS. (See Appendix E for approved measurement procedures.)

O. Subsection 4.5.1

O1. CURRENT VERSION OF SUBSECTION 4.5.1:

4.5.1 Narrow Band Transmit Spectrum

The first modulation sideband is defined as the energy around the carrier frequency extending to the theoretical first spectral nulls on both the positive and negative sides of the carrier. For NRZ-PSK modulation this is from F_C - R_S to F_C + R_S, where F_C is the carrier frequency and R_S is the symbol rate. The second sideband is defined as the frequency band from F_C + R_S to F_C + $2R_S$ and from F_C - R_S to F_C - $2R_S$. Third and higher sidebands are defined in a similar manner using $3R_S$, $4R_S$, etc.

The first sideband is the desired signal, all other sidebands are undesired.

When modulated with a random data stream, the 300 and 1200 bps signals shall produce sidebands with peak energy equal to, or less than, the following values.

Second sideband	-15 dBc
Third sideband	-25 dBc
Fourth sideband	-35 dBc
Fifth and higher sidebands	-45 dBc

Note: The sideband levels measured shall be referenced to the level of the unmodulated carrier.

Recommended Test Process:

The transmitter under test shall be operated into a 50 ohm load and at its maximum rated output power level. All measurements of the carrier and sideband levels shall be made with the spectrum analyzer controls set as follows:

Residual Bandwidth	30 Hz
Video Bandwidth	10 Hz
Sweep time	50 seconds
Level Sensitivity	5 dB per division

The frequency span shall be 5000 Hz for 1200 bps and 1250 Hz for 300 bps measurements.

These measurements will require the use of test data sequences that are longer than normally permitted to provide sufficient sweep time for accurate measurement.

NOTE: See Appendix E Test Notes for Random Data plots of the above transmit spectrum with the HDR Improved Test Transmitter.

O2. PROPOSED REVISION TO SUBSECTION 4.5.1:

4.5.1 Narrow Band Transmit Spectrum

The transmit spectrum shall be shaped using a Square-Root Raised Cosine (SRRC) filter with an excess bandwidth factor (α) of 1.0. The filter implementation shall match the theoretical SRRC shape to within ±1 dB between the -20 dB points on the theoretical curve.

When modulated by a data stream using the scrambler defined in subsection 3.2 above, the total power produced by the DCPRS outside of the filter roll-off bandwidth, due to signal sidebands, noise, and any other undesired emissions, when measured in any 100 Hz band, shall be at least 36 dB below the total power that is transmitted in the necessary bandwidth for 300 bps channels and 40 dB for 1200 bps channels. (The necessary bandwidth shall be from (carrier frequency - symbol rate in Hz) to (carrier frequency + symbol rate in Hz)).

P. Subsection 4.5.2

P1. CURRENT VERSION OF SUBSECTION 4.5.2:

4.5.2 Mid-Band Transmit Spectrum

With the transmitter set with a random 8 PSK modulation the Mid-Band and Harmonics shall be as set forth below:

For the 300 bps data rate at $F_o \geq \pm$ 1500 Hz $\leq$-60 dBc
For the 1200 bps data rate at $F_o \geq \pm$ 10000 Hz $\leq$-60 dBc

P2. PROPOSED REVISION TO SUBSECTION 4.5.2:

4.5.2 Mid-Band Transmit Spectrum

At any frequency separated by more than 250% of the necessary bandwidth from the carrier frequency, the total power emitted in any 4 kHz band shall be as set fourth in Recommendation ITU-R SM.329, Table 2 Spurious Limits – Category A:

43 + 10 Log(P) or 60 dBc, whichever is less stringent
Where P is the mean power applied to the antenna transmission line

This requirement shall be met for any type of transmission and under any combination of operational conditions.

Q. Subsection 4.6

Q1. CURRENT VERSION OF SUBSECTION 4.6:

4.6 Fail-safe Operating Requirements

An independent or separate fail-safe circuit shall be provided to prevent a DCPRS from operating in an uncontrolled fashion. This independent circuit must "permanently" shut off the transmitter if any of two conditions are violated. These two conditions are:

- Message is too long. For 300 BPS a DCP message length of ≥ 270 seconds shall trip the fail-safe. For 1200 BPS a DCP message length of ≥ 105 seconds shall trip the fail safe.

- Message sent is too soon. There shall be a minimum of 30 seconds off-time between successive transmissions. If a second message is transmitted before 30 seconds has expired, then the fail-safe shall be tripped.

The fail-safe capability must be demonstrated for all conditions over the defined operating a -40° C to 50°C temperature range and over the required power supply voltage variation. Removal of DC power from the DCPRS shall not affect the operation of this function.

Note: The above term "permanently" requires a manual intervention or reset of the DCPRS in order to restore the unit for operational use in the DCS.

Q2. PROPOSED REVISION TO SUBSECTION 4.6:

4.6 Fail-safe Operating Requirements

An independent or separate fail-safe circuit shall be provided to prevent a DCPRS from operating in an uncontrolled fashion. This independent circuit must "permanently" shut off the transmitter if either of the following two conditions are violated.

- Message is too long. A DCPRS message length >105 seconds shall trip the fail safe for either 300 bps or 1200 bps transmissions.

- Message is sent too soon. There shall be a minimum of 30 seconds off-time between successive transmissions. If a second message is transmitted before 30 seconds has expired, then the fail-safe shall be tripped.

The fail-safe capability must be demonstrated over the full range of operating conditions. Removal of DC power from the DCPRS shall not affect the operation of this function.

Notes:

1. **The above term "permanently" requires a manual intervention or reset of the DCPRS in order to restore the unit for operational use in the DCS.**
2. **The Inhibiting Transmission requirement of subsection 2.1.2 is specifically NOT included in this subsection.**

R. Appendix C

NOTE: The current DCPI link does not meet the ITU PFD requirement of -152 dBW/m2 in a 4 kHz bandwidth. The satellite EIRP must not exceed 40.1 dBmi to meet this PFD limit, which is 5 – 6 dB below the current DCPI transmit EIRP for the current system.

SOME CHANGE WILL BE NECESSARY

The proposed revision, included in section R2 below, is provided as an (incomplete) example of one possible set of changes that is thought might be the basis for an acceptable DCPI system. Any interested party is encouraged to propose additional or alternative content for this item.

R1. CURRENT VERSION OF APPENDIX C:

Appendix C - Interrogate DCP Receive Requirements

3.1 Received Frequency Characteristics - The DCP received radio-frequency (RF) shall be as follows:

a. The Geostationary Operational Environmental Satellite (GOES) East frequency - 468.8375 MHz.
b. The GOES West frequency - 468.8125 MHz or 468.825 MHz.
c. Furthermore, these frequencies shall be selectable without requiring realignment.

3.2. Interrogate Receive Signal Characteristics

a. Data Format - The DCP shall be capable of receiving and demodulating the following sequence:
1) 4 bit Binary Coded Decimal (BCD) time code followed by,
2) 15 bit MLS sync word (bit pattern 100010011010111) followed by,
3) 31 bit BCH interrogate address word (e.g. bit pattern 0011010010000101011101100011111 – MSB first in Hexadecimal. The DCPRS shall respond to one or more assigned addresses within 1 second. The DCPRS shall respond whenever the received sequence is exact or within two bits of the assigned address(es).

b. Acquisition Time

The receiver shall acquire lock-on to the interrogation signal format in two minutes or less, from standby conditions when the interrogation signal carrier is within ± 100Hz. The acquisition shall be accomplished in the presence of modulation.

c. Level

The DCP shall lock-on and demodulate the interrogation signal over the range of -100 dBm maximum to -130 dBm minimum centered at the carrier frequencies identified in paragraph 3.1 above measured at the receiver antenna terminals.

d. Mean Time to Cycle Slip (MTCS)

The MTCS for the carrier tracking loop shall be equal to or greater than 1 minute.

R2. PROPOSED REVISION TO APPENDIX C:

Appendix C - Interrogate DCP Receive Requirements

C.1 Received Frequency Characteristics - The DCP received radio-frequency (RF) shall be as follows:

a. The GOES East frequency - 468.8375 MHz
b. The GOES West frequency - 468.8125 MHz
c. Test/spare frequency - 468.8250 MHz

C.2. Interrogate Signal Characteristics

a. Modulation – BPSK NRZ-L
b. Data Rate (user) – 1200 bps
c. FEC Code – Rate 1/2 convolutional inner code plus Reed-Solomon (255, 223) outer code. (Same as will be used for LRIT and EMWIN on GOES N/O/P.)
d. RF Data Rate – 2736 bps
e. Data Filtering – SRRC (for transmitters and receivers) with excess bandwidth factor (α) of 1.0 (Same as will be used for LRIT and EMWIN on GOES N/O/P.)
f. Sideband Attenuation – -30 dBc minimum
g. Necessary Bandwidth – 5472 Hz
h. Satellite EIRP – 40.0 dBmi
i. Required bit error rate – 10^{-6}
j. Worst Case DCPRS G/T – -22 dB/K
k. Worst Case DCPRS Demod/Decode Implementation Loss – 2.0 dB
l. Receiver tracking loop bandwidth – 100 Hz (minimum)

Other Parameters:

Any interested parties are requested to offer other parameters to be included in the specification, or alternatives to those suggested above. At the very least, a definition of the digital interface, the content to be permitted, and the digital format, will need to be added to the above partial description, or any alternative that may be proposed.

NOTE:

The following link budget is attached for reference, showing the expected performance of a GOES N and a receive system that meets the above requirements. (It is not intended to be part of Appendix C, but is provided for reference only.)

Anyone who wishes to offer a different implementation for a new DCPI system must be compatible with the spacecraft capabilities shown therein. The performance of the GOES N/O/P satellites is essentially “cast in concrete.”

LINK BUDGET CALCULATIONS FOR PROPOSED NEW DCPI SERVICE		
Parameter	**Units**	**Value**
Data Rate, Rb	bps	**1200**
E/S Uplink Transmitter		
Frequency	MHz	**2034.9**
Transmit EIRP	dBmi	76.7
Antenna Pointing Loss	dB	0.5
Earth - To - Space Performance		
Path Distance @ 5 deg elevation	km	41126.8
Free Space Loss	dB	**190.90**
Atmospheric Attenuation	dB	0.36
S/C Receive Channel		
Polarization Loss	dB	0.2
U/L RSSi/Carrier	dBmi	**-115.26**
Antenna EOC Gain	dBi	13.5
Antenna Cable Loss	dB	0.35
Antenna Temperature	deg K	150
Payload Module N Temp	deg K	590.00
System Temperature	dBK	**28.69**
G/T	dB/K	**-15.54**
Boltzmann constant	dBm/Hz*K	**-198.6**
Uplink Thermal C/No	dB/Hz	**67.80**
S/C Transmit Channel		
Downlink Frequency	MHz	**468.825**
Transmit Power	Watts	1.19
Transmit Power	dBm	30.75
SSPA to Antenna Losses	dB	1.78
Antenna EOC Gain	dBi	10.6
Transmit EIRP	dBmi	**39.57**
Space - To - Earth Performance		
Path Distance	km	41126.8
Free Space Loss	dB	**178.14**
Atmospheric Attenuation	dB	0.15
E/S Downlink Receiver		
D/L RSSi/Carrier	dBmi	**-138.72**
Power Flux Density Rqmt at Subsat. Point	dBW/m2	-152
Power Flux Density at Subsatellite Point	dBW/m2	-152.40
E/S G/T	dB/K	-22
Polarization Loss (AR: 1.0/3.0)	dB	0.22
Boltzmann constant	dBm/Hz*K	**-198.6**
Downlink Thermal C/No	dB/Hz	**37.66**
Eb/No Overall Calculation		
Overall Composite C/No	dB/Hz	**37.65**
Data Rate, Rb	dB-Hz	**30.79**
Eb/No Calculated	dB	**6.86**
Required Eb/No Adjustments		
Required BER		**1.E-06**
Theoretical Eb/No	dB	**2.6**
Demod/Decode Implementation Loss	dB	**2.0**
Satellite Segment Degradations	dB	0.20
Required Eb/No	dB	**4.80**
Eb/No MARGIN	**dB**	**2.06**

RECEIVE G/T CALCULATION		
Noise Figure	2	dB
Noise Factor	1.58	ratio
Noise temp	168.2	deg K
Sky Temp	80	deg K
System Temp	248.2	deg K
	23.95	dB-K
Antenna Gain	3	dBi
Ant/LNA loss	1	dB
G/T	-21.95	dB/K

SIGNAL DYNAMIC RANGE		
(With 1 dB p-p EIRP variation)		
For above min antenna @ 5 deg EL		
=	-137.22	dBm
For 10 dBi antenna @ 90 deg EL		
=	-127.02	dBm

S. Appendix D

The current Appendix D is a listing of all 266 channels that are possible with the current frequency plan, with separate listings for 300 bps and 1200 bps channel designations. The proposed frequency plan would require a list of double that length for the 532 channels that are basically defined in subsection 4.2.

Is this listing necessary as part of this document?
Comments are requested.

T. Appendix E

The existing content of this appendix will no longer be applicable if the changes proposed above are implemented. Suggestions are requested.

One subsection that could be included is the phase noise budget for the end-to-end link.

Link Phase Noise Budget

A phase noise budget is proposed for the entire DCS so that each part of the system can be individually tested, independent of the other parts, and still be assured that all components that meet their assigned requirement will provide acceptable system function.

The proposed budget for the DCPRS is derived as follows :

1. The demodulators are expected to normally operate with a bit error rate near 1 in 10^7, and it is desired that errors due to phase noise should be about two orders of magnitude better, i.e., about 1 in 10^9.
2. Phase noise is a normal or Gaussian distributed variable, with standard deviation, σ. Therefore the dual-tail, Normal Error Integral gives a probability of 1 in 10^9 that it exceeds 6.1σ from its mean value.
3. The total phase error required to cause bit errors in an 8PSK demodulator is 22.5 degrees, half of the 45 degree phase shift between each of the nominal phase states.
4. This document proposes a DCPRS phase offset/bias 1.0 degrees.
5. 22.5 - 1.0 = 21.5 and 21.5 / 6.1 = 3.52
6. Therefore, the total system phase noise must be 3.5 degrees or less.
7. The phase noise in the GOES N primary and redundant DCPR transponders has been measured at 0.5 degrees, worst case. Therefore an allocation of 1.0 degrees is proposed for all of the GOES N and GOES R series of satellites.
8. The DCPRS phase noise required by the current Certification Standards is 2.5 degrees.
9. The phase noise allocation proposed for the dual down conversion receive path at WCDAS is 2.0 degrees.
10. The phase noise allocation proposed for the additional down conversion at the input to

the demodulators at WCDAS is 1.0 degrees.

11. The RSS for all these components of the system phase noise is 3.5 degrees.

The integration limits for calculating phase noise are 10 Hz and 150 Hz for the 300 bps channels and 36 Hz and 600 Hz for the 1200 bps channels. These are the values that will apply to the demodulators at WCDAS and have been set as the standard to be used for the satellite and DCPRS requirements. It is recommended that these values also be used in the design of future demodulators for WCDAS and/or DRGS, at these data rates.